We claim:

1. A method of compositional analysis of a heterogeneous material of one or more components, comprising steps of:

   (a) directing a pulse of laser radiation at a target of the heterogeneous material to ablate an amount thereof, and to form an ablation crater having a depth;

   (b) determining the concentration of one or more selected components in the heterogeneous material ablated from the target;

   (c) measuring the depth of the ablation crater, and

   (d) determining in situ and in real time a composition of the heterogeneous material at the depth.

2. The method according to claim 1, wherein any of steps (a) to (d) are repeated any numbers of times to determine the compositional profile of the heterogeneous material as a function of the depth.

3. The method according to claim 2, further comprising steps of:

   (e) shifting a target to a plurality of locations across the heterogeneous material, and

   (f) repeating steps (a) to (e) any number of times to determine a compositional profile of the heterogeneous material in three dimensions.

4. The method according to claim 2, wherein the step of measuring the depth of the ablation crater further comprises a step of:

   (g) measuring the depth at a plurality of points across the ablation crater to generate a depth profile of the ablation crater.

5. The method according to claim 4, further comprising steps of:

   (h) repeating step (g) at a plurality of depths of the ablation crater; and

   (i) generating an evolution of the depth profile of the ablation crater.

6. The method according to claim 3, wherein the step of measuring the depth of the ablation crater further comprises a step of:

(j) measuring the depth at a plurality of points across the ablation crater at a plurality of ablation craters to generate a compositional profile of the heterogeneous material in three dimensions.

7. The method according to claim 2, further comprising a step of processing data from steps (a) to (d) to correspond with each other to generate the compositional profile of of the heterogeneous material as a function of the depth.

8. The method according to claim 3, further comprising a step of processing data from steps (a) to (e) to correspond with each other to generate the compositional profile of the heterogeneous material in three dimensions.

9. The method according to claim 1, wherein the concentration is determined by a spectrochemical analysis technique selected from a group consisting of: optical emission spectrometry of the light emitted by the plasma produced above the target concomitantly with the laser ablative event, optical emission spectrometry, following the introduction of the material ablated from the target into an auxiliary plasma discharge where said material is excited to emit light, and mass spectrometry of said material ablated from the target, following the introduction of the ablated material into said auxiliary plasma discharge, from which the ablated material is extracted in ionized form.

10. The method according to claim 1, wherein the depth is measured by a technique selected from a group consisting of: confocal microscopy, laser triangulation, and interferometry using a short coherence length light source.

11. The method according to claim 10, wherein the depth is measured by the interferometry which comprises steps of:

directing a short coherence length light to both the ablation crater and an interferometric mirror, and

measuring interference between light reflected from the ablation crater and the interferometric mirror.

12. The method according to claim 11, further comprising steps of:

scanning the short coherence length light across the ablation crater, and

measuring interference between light reflected from the ablation crater and the interferometric mirror to generate a depth profile of the ablation crater.

13. The method according to claim 10, further comprising steps of:

directing a short coherence length light to inside the ablation crater, outside the ablation crater and an interferometric mirror, and

measuring interference between light reflected from the inside of the ablation crater and the interferometric mirror and between light reflected from the outside of the ablation crater and the interferometric mirror.

14. The method according to claim 10 wherein the depth is measured by the interferometry in which the short coherence light is located colinearly with the laser radiation.

15. The method according to claim 10 wherein the depth is measured by the interferometry in which the short coherence light is located at an angle with the laser radiation.

16. An apparatus for compositional analysis of a heterogeneous material of one or more components, comprising:

a laser source for producing an ablation beam of laser pulses of sufficient fluence to ablate an amount of the heterogeneous material from a target under study and thereby to form an ablation crater of a depth;

a spectrometric device for detecting and determining the concentration of one or more selected components in the heterogeneous material ablated from the target;

an optical device for measuring in situ and in real time the depth of the ablation crater.

17. The apparatus as claimed in claim 16, wherein said spectrometric device is selected from a group consisting of: an optical spectrometric device for a spectrochemical analysis using light emitted by plasma produced above the target concomitantly with the laser ablative event, an optical spectrometric device for a spectrochemical analysis using light emitted by an auxiliary plasma discharge into which the material ablated from the target is introduced, and a mass spectrometric device for determining the concentration of one or more selected components in the material ablated from the target and subsequently ionized.

18. The apparatus as claimed in claim 16, wherein said optical device for measuring the depth of the ablation crater is selected from a group consisting of a confocal microscopy device, a laser triangulation device, and an interferometer using a short coherence length light source.

19. The apparatus as claimed in claim 16, further comprising a mechanical device for scanning a beam of the optical device across the target for measuring the depth of the ablation crater.

20. The apparatus as claimed in claim 16, wherein said optical device for measuring the depth of the ablation crater comprises a dual measuring beam system for a simultaneous measurement at two points on the sample surface, one inside the crater substantially at its center and the other one outside the crater in a region unaffected by ablation and residual debris.

21. The apparatus as claimed in claim 16, further comprising a dichroic plate for superimposing the ablation beam and a beam of said optical device for measuring the depth of the ablation crater so as to be substantially colinear.

22. The apparatus as claimed in claim 16, wherein a beam of said optical device for measuring the depth of the ablation crater forms an angle relative to said ablation beam.

23. The apparatus as claimed in claim 16, further comprising means for generating the ablation beam of substantially uniform radial distribution of energy, thus producing a crater with flat bottom and steep walls.

24. The apparatus as claimed in claim 16, further comprising a data processing device for processing data from the spectrometric device and the optical device to correlate one another.

25. The apparatus as claimed in claim 16, further comprising a data processing device for processing data from the laser source and the optical device to correlate one another to generate an evolution of a depth profile of the crater.